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DROUGHT, ITS AFTER-EFFECTS, AND MANAGEMENT STRATEGIES FOR WOODY ORNAMENTALS

During the past few years, symptoms of drought stress have been visible on many woody plants in landscapes, natural woodlots, and forests throughout Connecticut. Records at the Experiment Station's Lockwood Farm in Mt. Carmel reported abnormally low levels of precipitation in May, July, August, and September 2005. In fact, low precipitation has been a recurring problem since 1995, which was characterized as the worst drought in 30 years and as the driest summer since 1944. Rainfall deficits were also recorded for the growing seasons of 1997, 1998, 1999, 2001, and 2002. When trying to define a "drought year," the pattern and frequency of precipitation is more important than the total amount of precipitation recorded for the year. Total precipitation levels can be deceiving when interpreted solely on the basis of yearly amounts rather than on a month-by-month basis. This is because one or two significant precipitation events or storms in a year could account for much of the total precipitation recorded for that year. Therefore, it is the amount and frequency of precipitation rather than yearly totals that are important to the long-term health, growth, and vigor of woody plants. This is especially true during the growing season when water demands are the greatest. Up-to-date information on precipitation levels recorded at the Experiment Station's Lockwood Farm can be found at the Station web site (http://www.caes.state.ct.us/).

Drought causes primary and secondary physical damage as well as physiological changes in woody plants. The primary physical effect of drought or dry soil conditions is direct damage to the roots and root death. The root system of a woody plant has four types of roots: 1) framework roots consisting of primary and secondary woody roots, 2) transport and storage roots, 3) nonwoody feeder roots, and 4) root hairs. Almost 99% of this root mass is in the top three feet of the soil. The feeder roots and root hairs, which are in the top 12 inches of the soil, are responsible for uptake of water and nutrients. Unfortunately, they are the first portion of the root system to be affected by drought since they are very sensitive to drying. When feeder roots and root hairs become nonfunctional, a water deficit develops in the plant because these roots can no longer provide sufficient water to the top of the plant. In addition to direct damage to the root system, drought triggers metabolic changes. Among these are changes in hormone levels and other physiological factors (e.g., factors that influence the number of leaves that will emerge the next year or that are responsible for the closing of stomates).

SYMPTOMS:

Symptoms of drought are manifest in many different ways depending on the plant species and the severity of the water deficit. One important aspect of drought is the fact that the symptoms are often not evident in the top of the tree or shrub until sometime after the event has occurred-- even as much as one to two years later! Symptoms include loss of turgor in needles and leaves, drooping, wilting, yellowing, premature leaf or needle drop, bark cracks, and twig and branch dieback. Leaves on deciduous trees often develop a marginal scorch and interveinal necrosis whereas needles on evergreens turn brown at the tips. Trees and shrubs can also exhibit general thinning of the canopy, poor growth, and stunting. In extreme cases, drought can result in plant death.

In addition to direct root damage, a significant secondary effect of drought is that it weakens plants and predisposes them to secondary invaders and opportunistic pests such as fungal tip blights, vascular wilts, root rots, and needlecasts. Among the key secondary problems are:

1. Winter Injury-- Drought-stressed woody ornamentals are not as winter-hardy as their healthy counterparts.

2. Root Problems-- Injured or weakened root systems are more susceptible to root rots.

Example:

a. Armillaria Root Rot- Causal Agent: *Armillaria mellea*
Hosts: many species including pine, fir, oak, maple

3. Cankers-- Weakened woody ornamentals have slowed "defenses" and wound healing is inhibited.

Examples:

a. Nectria Canker- Causal Agent: *Nectria* spp.
Hosts: many species, maple, birch

b. Hypoxylon Canker- Causal Agent: *Hypoxylon* spp.
Hosts: many species, oak

c. Bleeding Canker- Causal Agent: *Phytophthora* spp.
Hosts: many species, esp. beech

d. Botryosphaeria Canker- Causal Agent: *Botryosphaeria dothidea, B. obtusa*
Hosts: many species, oak, maple, crabapple

4. Wood Rots-- Slowed defenses limit compartmentalization and reaction to invasion by wood-rotting fungi.

Examples:

a. Fomitopsis on red spruce
b. Fomes on maple
c. Polyporus

5. Sensitivity to Pesticides-- Weakened woody ornamentals are more sensitive to pesticides; compounds that do not cause problems for healthy plants can result in phytotoxicity on drought-stressed plants.

Examples: various herbicides, insecticides, and fungicides

6. Sensitivity to De-icing Salts-- Weakened woody ornamentals are more sensitive to de-icing salts, especially sodium chloride.

7. Miscellaneous Diseases-- An increase in the frequency and severity of several diseases has been associated with drought stress.

Examples:

a. Sphaeropsis Tip Blight-	Causal Agent: *Sphaeropsis sapinea*
	Hosts: pine, esp. two- and three-needled species
b. Rhizosphaera Needlecast-	Causal Agent: *Rhizosphaera kalkhoffii*
	Hosts: spruce, esp. blue spruce
c. Cytospora Canker-	Causal Agent: *Leucostoma kunzei*
	Hosts: spruce, esp. blue spruce
d. Verticillium Wilt-	Causal Agent: *Verticillium* spp.
	Hosts: many woody plants, esp. Japanese maple
f. Dutch Elm Disease-	Causal Agent: *Ophiostoma ulmi* and *O. novo-ulmi*
	Hosts: elm
g. Ash Yellows-	Causal Agent: Phytoplasma
	Hosts: ash, especially white and green ash
h. Elm Yellows-	Causal Agent: Phytoplasma
	Hosts: elm

Native plants growing naturally in woodlots or forested areas are usually adapted to regional and seasonal fluctuations in the amount of precipitation and only *unusually* severe drought causes problems for them. However, planted landscape trees and shrubs often show symptoms of drought and severe water stress. Planting practices are frequently key sources of this problem since we often plant in unfavorable sites, don't prepare the rootball properly, plant too deep or too shallow, or mulch so thickly that water doesn't penetrate into the soil.

Symptoms of drought can develop on a wide range of deciduous and evergreen trees and shrubs and are particularly severe on seedlings and new transplants. This is because their roots occupy the uppermost layers of soil where the most rapid drying occurs. In addition, recent transplants typically lose important feeder roots during the transplant process. For example, balled and burlapped trees are estimated to contain only 5-20% of their original root mass after digging. For container-grown ornamentals, the medium in which the transplant is growing can be a key factor— many of the soilless mixes used for container stock are highly porous, dry out very quickly, and are very difficult to re-wet. This situation creates moisture stress in the rootball regardless of the availability of water in the surrounding soil. This problem often continues until the roots grow beyond the rootball. Contrary to popular opinion, it often takes woody transplants two years to become completely established in a new site. Thus, these plants should be given extra care and attention during periods of drought. Established trees and shrubs are also affected by drought, especially in marginal sites such as those with pavement over their roots, street trees, and those in pockets of soil on ledges or in sandy soils. Problems have also been observed on apparently established trees and shrubs that have survived despite improper planting. Once stressed by drought, these trees quickly decline and often die.

STRATEGIES FOR MANAGING DROUGHT PROBLEMS:

While there is no cure for this problem, the effects of drought can be minimized by following some preventative measures:

1. Water in periods of low soil moisture--

Trees and shrubs require approximately one inch of water per week. Special attention to young trees is important. For most soil types, water is best applied at one time as a slow, deep soaking of the entire root zone to a depth of approximately 12-18 inches. The length of time required to "deep-water" will vary depending on soil type and water pressure: clay soils usually require more time than sandy soils. Frequent, light, surface watering will ***not*** help the tree and can actually cause harm by promoting growth of surface roots. A deep soaking just before the ground freezes in the fall will also help the winter hardiness of drought-stressed plants.

2. **Select the appropriate site and follow good planting practices--**
   Drought stress can magnify even the most subtle improper planting practices (e.g., planting too deep, too shallow, failure to remove or cut the burlap and/or the wire basket). When planting a tree, try to anticipate the water needs of that tree at maturity.

3. **Select native plants or match plant species to site conditions--**
   Drought-sensitive (e.g., dogwood, some oaks, ash, birch) *vs.* drought-tolerant (e.g., most pines, junipers, many *Prunus*, larch).

4. **Mulch to maintain soil moisture--**
   Properly applied mulches can be very helpful. Mulches are usually applied 1-3 inches thick and spread evenly out to the drip line of the tree. It is also important to keep the mulch 6-12 inches away from the trunk. Mulches that are applied too thickly or too close to the base of the tree ("volcano" or "pyramid" mulches) can be harmful!

5. **Prune any dead or weakened tissues to avoid secondary problems--**

6. **Maintain plant vigor by following good cultural practices--**
   It is generally accepted that trees under stress should not be fertilized. However, applications of biostimulants, mycorrhizae, or similar compounds can be beneficial and can help to stimulate root growth and regeneration.

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